UC Davis

Dermatology Online Journal

Title

Decreased phototherapy effectiveness on lower body

Permalink

https://escholarship.org/uc/item/7pg2g8zf

Journal

Dermatology Online Journal, 25(6)

Authors

Piccinin, Meghan A
Cline, Abigail
Feldman, Steven R

Publication Date

2019

Decreased phototherapy effectiveness on lower body

Meghan A Piccinin[1], Abigail Cline[1], Steven R Feldman[1,2]

Affiliations: [1]Center for Dermatology Research, Department of Dermatology, Wake Forest School of Medicine, Winston-Salem, North Carolina, USA, [2]Department of Public Health Sciences, Wake Forest School of Medicine, Winston-Salem, North Carolina, USA

Corresponding Author: Meghan Piccinin, Department of Dermatology, Wake Forest School of Medicine, Medical Center Boulevard, Winston-Salem, NC 27157-1071, Tel: 336-716-7740, Fax: 336-716-7732, Email: piccininma@upmc.edu

Abstract

Although phototherapy is an effective treatment for many dermatological conditions on the face, trunk, and proximal extremities, a common issue plaguing whole-body phototherapy is its diminished efficacy on the legs. In this commentary, we elaborate on the factors underlying this phenomenon, as well as potential solutions to improve treatment success.

Keywords: phototherapy

Introduction

Phototherapy is a commonly-employed treatment modality for a number of cutaneous disorders, including atopic dermatitis, vitiligo, and psoriasis. Although phototherapy is an effective treatment for many dermatological conditions on the face, trunk, and proximal extremities, a common issue plaguing whole-body phototherapy is its diminished efficacy on the legs [1, 2]. In this commentary, we elaborate on the factors underlying this phenomenon, as well as potential solutions to improve treatment success.

Ultraviolet (UV) B phototherapy with a wavelength of 280-315 nanometers is largely restricted to the epidermis. Thus, the physiologic response to phototherapy is dictated by the effective dose of irradiance received at the skin surface [3]. The irradiance, or photonic emission, from a phototherapy tube may be modelled as a continuum of point sources arranged into a linear series [3]. Each individual point source emits a diffuse spherical array

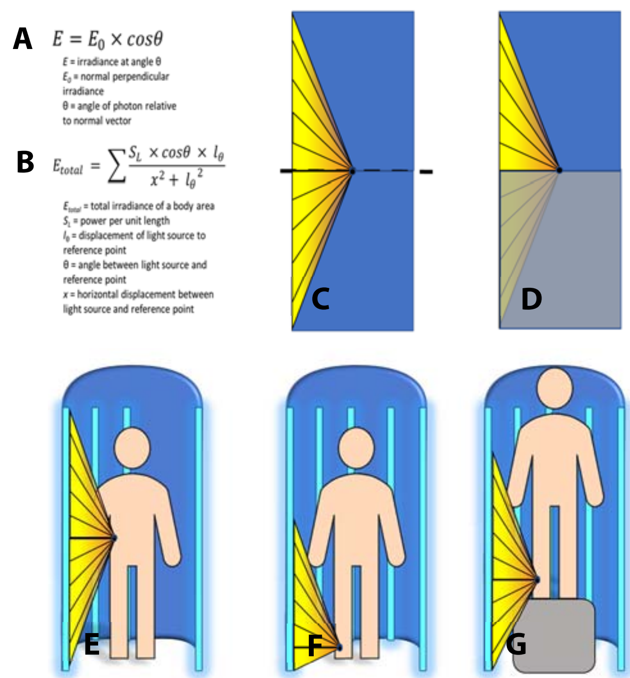

Figure 1. *Relative irradiance of body regions during phototherapy treatment.* ***A)*** *The Lambert Cosine Law demonstrates that the irradiance provided by an angled photon is proportional to its angle from the normal.* ***B)*** *The total irradiance received by a point is equal to the summation of the irradiance provided by each individual photon.* ***C)*** *A detector placed at the midpoint of the cabin receives irradiance from above and below.* ***D)*** *If only light sources above the level of the detector are considered, the detector will receive 50% of the total irradiance, equivalent to the irradiance at the bottom of the chamber.* ***E)*** *The midbody receives irradiance from above and below.* ***F)*** *The legs receive high-energy photons from light sources directly opposed to the region, as well as lower-energy photons from superior light sources. The legs do not receive irradiance from below.* ***G)*** *Having the patient stand on a stool within the phototherapy cabin allows for increased irradiation of the lower extremities by inferior sources, increasing the total radiant dosage received by the legs.*

of photons that strike the patient's body at a variety of angles. As the angle of the photon increases relative to the normal plane, the radiance provided by that specific photon diminishes in proportion to the cosine of the angle of incidence, in accordance with the Lambert Cosine Law (**Figure 1A)**, [4].

Based on this law, photons emitted at a lesser angle will contribute more radiant energy to total irradiance than those emitted from sources high above or far below the target body region and the total energy received at any point on the body will equal the sum of energy contributed from all point sources (**Figure 1B)**, [3, 5]. A detector placed in the middle of the phototherapy chamber will receive irradiance from above and below (**Figure 1C)**. Alternatively, a detector placed at the base of the cabin will receive irradiance only from above, resulting in a radiation dose half of that received in the middle of the booth (**Figure 1D)**.

The middle area of the body receives high-energy photons from the regions of the tube located in direct apposition, as well as lower-energy photons from superior and inferior regions of the tube (**Figure 1E)**. Alternatively, the legs receive high-energy photons from the directly apposed regions of the tube and lower-energy photons from superior sections of the cabin but fail to receive photonic energy from light sources located below (**Figure 1F)**. Thus, the distal lower extremities receive a lower effective dose of irradiation relative to the central body regions, contributing to their apparent resistance to conventional phototherapy.

Discussion

To overcome this therapeutic challenge, a stepstool within the phototherapy cabin can be used move the legs up and away from the bottom of the phototherapy unit, increasing the irradiance to the legs by inferiorly-located light sources (**Figure 1G)**. Alternatively, patients may undergo additional or prolonged leg-specific phototherapy sessions by dressing the patient in a UV-protective gown or robe to restrict irradiation to the legs. Enacting modifications that allow for greater dosing of the legs and ensuring more equivalent full-body dosing may lead to improved clinical outcomes for patients with 'stubborn' cutaneous disease of the lower extremities.

Potential conflicts of interest:Dr. Feldman is a consultant and speaker for Galderma, Abbvie, Celgene, Abbott Labs, Lilly, Janssen, Novartis Pharmaceuticals, Sanofi, Sun Pharma and Leo Pharma Inc. He has received grants from Galderma, Janssen, Abbott Labs, Abbvie, Celgene, Taro, Sanofi, Celgene, Novartis Pharmaceuticals, Qurient, Pfizer Inc. and Anacor. He is a consultant for Advance Medical, Caremark, Gerson Lehrman Group, Guidepoint Global, Kikaku, Lilly, Merck & Co Inc, Mylan, Pfizer Inc, Qurient, Sienna, Suncare Research, Valeant, and Xenoport. Dr. Feldman is the founder, chief technology officer and holds stock in Causa Research. Dr. Feldman holds stock and is majority owner in Medical Quality Enhancement Corporation. He receives royalties from UpToDate, Informa and Xlibriss. Meghan Piccinin and Abigail Cline have no conflicts of interest to disclose.

References

1. Moseley H, Allan D, Amatiello H, et al. Guidelines on the measurement of ultraviolet radiation levels in ultraviolet phototherapy: report issued by the British Association of Dermatologists and British Photodermatology Group 2015. *Br J of Dermatol*. 2015;173(2):333-50. [PMID: 26346088].
2. Shan X, Wang C, Yang B, Zhang F. A comparison of irradiance at different body sites in whole-body narrowband-ultraviolet B cabins. *Indian J Dermatol Venereol Leprol*. 2012;78(6):745-6. [PMID: 23075646].
3.
4. Grimes DR, Robbins C, O'Hare NJ. Dose modeling in ultraviolet phototherapy. *Med Phys*. 2010;37(10):5251-7. [PMID: 25563284].
5. Weik MH. Lambert's cosine law. In: Computer Science and Communications Dictionary. Weik M, editor. Springer; 2000. p. 868. [DOI: 10.1007/1-4020-0613-6_9901].
6. Grimes DR. Ultraviolet radiation therapy and UVR dose models. *Med Phys*. 2015;42(1):440-55. [PMID: 25563284].